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## Semantic Memory Organization In Children And Young Adults

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### Abstract

The study of the organization of semantic memory has become of great interest in the cognitive psychology field and in neuropsychological research. Semantic knowledge considered to be represented by concepts, which can be related taxonomically (when they are hierarchically organized) or thematically (when they are linked by cross-categorical relations). Both relations arise from distinct processes, as evidenced by numerous neuropsychological and behavioral dissociations. Many works have stated that the production of thematic relations outnumbers that of taxonomic relations in children, and that as they grow older a thematic-to-taxonomic shift occurs, while others claim that such a shift does not take place and state that one major problem is that the tasks used in previous studies to assess concept-relations are biased. In our work we performed a feature production task in such a way that subjects could freely associate concepts with their features. Our results, using this non-biased-task, show that the evocation of taxonomic relations was higher in the adult group (formed by thirty 20-to 40-year-olds) compared to the children group (formed by forty-eight 6-to 9-year-olds), but that, nonetheless, thematic relations were still present in the adult group. This suggests, instead of a thematic-to-taxonomic shift in adulthood, the coexistence of both types of relations, which is crucial to research on language structure and conceptual knowledge. Thus, our results contribute to the understanding of semantic knowledge organization and provide valuable groundwork to the development of clinical instruments used in neuropsychological tests to assess language, attention and semantic memory, where precise information of concept-relations is crucial.

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### 1. Introduction

Object categorization is certainly one of the most essential and adaptive activities of human cognition [1]. Not

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only do categories allow one to function efficiently by organizing knowledge about the environment, but also they are also powerful means to infer properties of objects on the basis of their categorical belongings [2]. In relation to this, the study of the organization of semantic memory has become of great interest in the cognitive psychology and in neuropsychological research. Semantic knowledge considered to be represented by concepts, which can be related taxonomically (when they are hierarchically organized) or thematically (when they are linked by cross-categorical relations). Both relations arise from distinct processes, as evidenced by numerous neuropsychological and behavioral dissociations.

The first theories of cognitive development proposed that categorization performed by children experienced a shift through developmental sequences, by which it evolved from a thematic to a more taxonomic organization. Similarly, more recent investigation suggested that thematic relations existed at the origin of the semantic development; hence, playing a more central role in the organization of semantic memories in children than taxonomic relations. On the other hand, taxonomic relations would predominate in young adults.

However, a few authors have recently argued against this thematic-to-taxonomic shift, stating that both types of relations are essential for object categorization in everyday life, and both would be present in preschoolers and adults. Moreover, evidence has shown that information related to living things (animals, fruits, vegetables) is usually more perceptual and taxonomic, than the one related to nonliving things, which is more thematic.

By far, the single most common method ubiquitously used to measure thematic and taxonomic thinking is the *matching-to-sample* task, where a stimulus is presented with two or more option stimuli and participants are instructed to choose the option that matches the base on some given criterion. One major problem is that the tasks used in previous studies to assess concept-relations, such as the *matching-to-sample* task, are biased, as they explicitly required the evocation of these relations. For instance, in picture matching tasks, subjects were asked to choose between two different pictures the one that “went well” with the target, which favors thematic relation responses.

Thus, our experiments were primarily designed to study in a nonconfounded manner whether a thematic-to-taxonomic shift occurred from children to young adults, by using a feature production task in such a way that subjects could freely associate and evoke concepts related to a particular target, which could be a living or nonliving thing.

## 2. Materials and Methods

### 2.1 Participants

Forty-eight children, aged between 6 and 9 years old at the time of administration, attending 1st ( $n = 24$ ) and 3rd ( $n = 24$ ) year of basic primary education in a private school in Mar del Plata, Argentina; and thirty young adults aged between 20 and 40 years old, students or graduates from college or university education participated in the study.

### 2.2 Method

An attribute-of-concepts-production-task was used. Twelve images of concepts were presented from four different categories (animals, fruits, furniture and tools), taken from the Cychowicz et. Al (1997) standardized set of images, normalized in our country by Manoilloff et al. (2010).

The task was introduced to the children as if it was a game; the images were shown one by one; participants were asked to nominate them (as a guarantee that they knew them) and were asked to describe them to a child who could not see them (without naming them). Before beginning the task, an example was shown, illustrating that they should mention the attributes, which define the concepts, but not any association. As the six-year-old children were unable to write, they were asked to perform the task orally and the experimenter kept written record for them.

Adults were asked to evoke attributes of concepts, also presented as images, which alluded to perceptual characteristics (how they looked, how they sounded, how they smelt, etc.), their habits and their habitat (what they did, where they lived), their functions and the situations in which they were involved (what they were used for, where and when they were used), the category to which they belonged or other encyclopedic data.

### 2.3 Codes

Attributes were classified into two different kinds of conceptual relations. The *taxonomic* relations (including the superordinate level (bird-animal), coordinate (bird-parrot) and subordinate (sparrow-parrot) and *thematic* relations, which included spatial (couch-is located in the living room), temporal (butterfly-spring), action (whistle-you can put a piece of string), functional (chair is for sitting) and event relations (rocking-grandmothers use it).

## 2.4 Data analysis

SigmaStat and SigmaPlot software were used. Parametric statistic was used (*t* test and *ANOVA*) if data met the assumptions required by those statistics: homoscedasticity (evaluated through *Levene's* test, and normality assessed by *Shapiro-Wilks* test). In cases where the assumptions were not met, we proceeded to perform nonparametric statistics, such as the *Kruskal-Wallis* test.

## 3. Results

The mean percentage of taxonomic and thematic features produced by children and adults was compared (Fig. 1) using a *Kruskal-Wallis* test and a *post-hoc* comparison (*chi-square* = 136.34; *df* = 3;  $p < 0.01$ ;  $n_{\text{children}} = 48$ ;  $n_{\text{adults}} = 30$ ). The adults produced a higher percentage of taxonomic features than children ( $p < 0.01$ ); and children showed a higher percentage of thematic features ( $p < 0.01$ ). However, both groups, children and adults, produced a significantly higher number of thematic features than taxonomic ones ( $p < 0.01$ ).

Secondly, a deeper analysis of the data was performed, classifying the target to which the features were attributed to, into 4 distinct categories: animals and fruits (living things) and objects and furniture (nonliving things). The mean percentage of taxonomic and thematic features produced by children and adults for the different 4 categories was compared (Fig. 2) using a 1-way-*ANOVA* test and a *post-hoc* comparison for the percentage of features produced by adults ( $F = 35.58$ ; *df* = 7;  $p < 0.01$ ;  $n_{\text{adults}} = 30$ ) and a *Kruskal-Wallis* test and a *post-hoc* comparison for the percentage of features produced by children (*chi-square* = 133.11; *df* = 7;  $p < 0.01$ ;  $n_{\text{children}} = 48$ ). Both groups, children and adults, presented more taxonomic features for living categories (animals and fruits); and more thematic features related to nonliving things (objects and furniture).

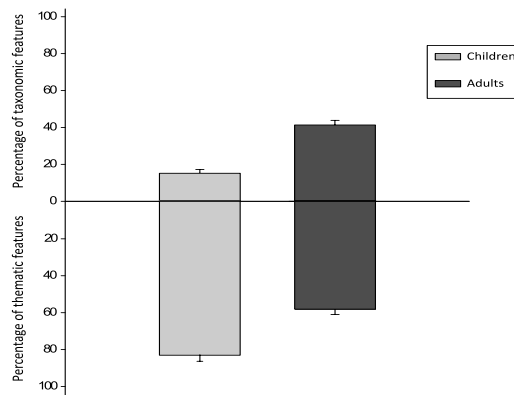


Fig. 1. Percentage of taxonomic and thematic features in children and adults.

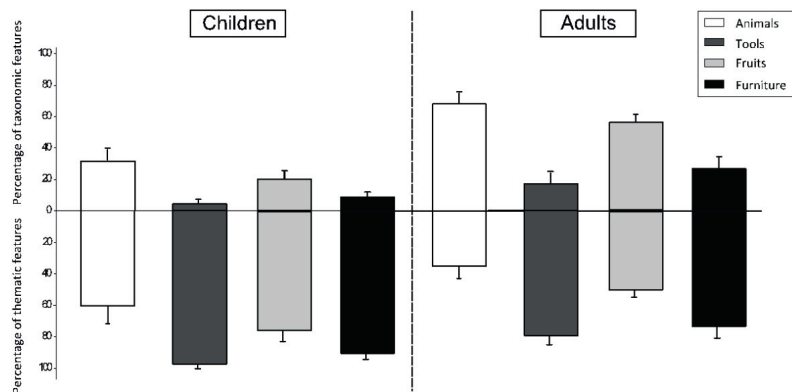


Fig. 2. Percentage of thematic and taxonomic features for living (animals and fruits) and nonliving (tools and furniture) things in children (left) and adults (right).

#### 4. Discussion

Firstly, our results provide clear evidence that adults produced more taxonomic features than children, and that this last group produced more thematic ones than adults. Secondly, so far, previous work has shown a thematic-to-taxonomic shift occurring in adults. However, this previous research poses some difficulties because of different methodological problems (see Introduction). In the current experiments, we conclusively showed that both groups, children and adults, produced more thematic related concepts than taxonomic ones; hence, providing evidence that, despite the age, the thematic organization of the knowledge is not replaced for a taxonomic one. On the contrary, both types of categorization coexist in adults. These findings are in line with those of Waxman & Namy (1997) and Borghi & Carmelli (2003).

Many works have shown that education; formal schooling and training analytical skills contribute to the preference of taxonomic relations between concepts. Hence, the higher use of taxonomic features in adults (Fig. 1) could be explained in terms of a differential cognitive development, due to educational experience. The inclusion of more taxonomic relations between concepts in adult would arise because of this cognitive experience, but would not replace thematic ones. Thematic relations are intrusive, fast and frequent. They are apprehended involuntarily in tasks for which they are irrelevant and even counterproductive. Therefore, it is expected that they will remain present even in adults (Fig. 1 and Fig. 2) and appear even more frequently than thematic ones.

Moreover, we also found a differential production of thematic and taxonomic relations according to the target domain (Fig. 2). Both, children and adults produced more taxonomic relations for living things (animals and fruits); and more thematic features for nonliving things (objects and furniture). These results are in accordance to found by Kalenine and Bonthoux, 2008 [15], which show that thematic relations (in particular, contextual/functional relations such as usage and location) are more useful in the classification of artefacts than living things.

The study of semantic features and evocation of concept-associations is essential for the empirical contrast of theoretical hypothesis and models on the functioning of semantic memory. The distinction between thematic relations and taxonomic relations is more than theoretical, as thematic thinking and taxonomic thinking arise from distinct processes. The evidence from neurological impairments and neuroimaging, both indicate that thematic processing and taxonomic processing have important differences in neural topography and cortical networks. Our work provides an insight into a better understanding of the organization of semantic information in children and adults, in a nonconfounded manner due to its experimental design which allowed the subjects to freely associate concepts by evoking its features related to a target, either thematically or taxonomically. These results provide valuable information for the elaboration of evaluation instruments used in clinical practice; such as neuropsychological tests aimed at evaluating language, attention and the acquisition, consolidation and evocation of semantic memory.

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